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Grafting and Budding Fruit Trees

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GRAFTING AND BUDDING FRUIT TREES

I. P. LEWIS

Almost every fruit grower, sooner or later, finds it desirable and oftentimes necessary to practice the art of grafting in some of its forms. Mistakes sometimes occur at the nursery, and trees turn out to be untrue to name. The grower may order trees that prove to be of an undesirable variety by the time they begin to bear fruit. The ever changing market demand may make it desirable to change trees already bearing into more desirable sorts. To facilitate pollination, grafting of occasional trees in a block of a single variety may be advisable. The grower may have a certain tree from which he wishes to propagate; or, because of accident, rodent injury, or disease, it may be necessary to do repair work involving certain types of grafting.

The art of grafting has been practiced for many centuries, and there have been countless variations in methods of grafting. Long experience, however, has shown that certain methods are more likely to succeed under ordinary conditions, and these, together with a few of the newer materials and methods with which the writer has experimented, are given here.

Since fruit varieties, with rare exceptions, do not come true from the seed, they are largely propagated from vegetative parts by grafting; that is, a piece of twig (called the scion) of the particular kind wanted is transferred to a growing root or limb (called the stock) and united with it in such a manner that a perfect union is secured. The scion continues to grow as if it were on its own roots and produces fruit of its kind. Grafts are more successfully made between varieties of the same species or between closely related species of a genus.

Grafting is generally divided into two major divisions: (1) scion grafting and (2) bud grafting or budding. Each of these divisions is again divided into many subdivisions according to the different methods and parts used in making the union.

Since growth takes place in the cambium and other closely associated meristematic cells beneath the inner bark, it is essential to bring the cambium tissue of both stock and scion in contact with each other, their subsequent growth forming a continuous layer of new wood uniting the parts as one. The cambium tissue is a single layer of cells lying just between the inner bark and the wood; there

are usually several layers of cells adjacent to the cambium which have not become differentiated into other tissues, and these cells with the cambium are termed the cambial region. The cambium layer is the tissue of the stem which accounts for diameter increase, and further growth depends on its preservation. The viscid-like, slippery substance that is evident when the bark peels at the time of active tree growth is largely derived from the contents of cambium cells.

SELECTION AND CARE OF SCIONS

The selection and care of scion wood for grafting are of utmost importance. Twigs that have made growth of from 1 to 2 feet during the preceding season usually furnish the best scion wood. The buds should be plump and mature. The mid-portion of the one-year growth furnishes the best scions; basal and tip portions of most one-year growth contain under developed and weak buds. Two- or 3-year wood may be used at times under special conditions but is not recommended.

It is essential that scions be kept dormant until set in the stock. Scions may be cut during the winter while dormant, but care should be taken to keep them cool and moist until time for using. They should be wrapped in cloth or paper and buried in the ground below frost level in a well drained location, or they may be stored in a cool cellar in slightly moistened sand, sawdust, or sphagnum moss.

TABLE 1.—Comparison of Stored and Paraffined Scions with Those Freshly Cut

Treatment of scions	Grafts set	Successful grafts	Percentage successful, set December to May	Percentage successful, set March and April
Stored in moist sawdust	103	33	32.0	75.0
Coated with paraffin, stored in sawdust ..	107	50	46.7	88.3
Freshly cut from trees before setting.....	84	52	61.9	88.8

An experiment was conducted comparing grafts made with scions that had been stored and grafts made with scions that had been freshly cut from the trees just before using. A third lot of grafts was also made with scions that had been dipped in melted paraffin before storing. The scions were stored in moist sawdust in a cool cellar under uniform conditions. Grafts were made from each lot of scions at intervals from December until growth started in April. The results in Table 1 indicate that the scions coated

with paraffin before storing were superior to those stored without coating and were practically equal to freshly cut scions, especially for use during March and April, the normal grafting season.

If scions stored in sawdust alone are kept moist and cool they will give good results. However, since stored scions are often neglected, coating with melted paraffin before storing insures the holding of the moisture in the scions.

Best results are obtained in coating scions with paraffin wax if they are quickly dipped in wax having a temperature of 170 to 180 degrees Fahrenheit, which is just below the point where the wax becomes smoking hot. The temperature should not be above this point or the hot wax may cause injury, and it should not be below 160 degrees Fahrenheit or too heavy a coating will be secured and will have a tendency to crack and flake off. These coated scions may be shaped and the grafts made with them in the spring. This coating of wax remains on the scions after being set and materially aids in the possibility of making a successful graft union with the stock.

TIME OF GRAFTING

The cutting of scions in the spring just before growth starts and grafting immediately are ideal, but the time is so short during which this can be done that a very limited amount of grafting can be accomplished. Where scions can be kept dormant in storage, grafting can be successfully done even though the trees have attained considerable growth. The general rule for successful grafting is that scions should be as dormant as, or more dormant than, the stock. By using basal growth from small 2- or 3-year twigs containing latent, dormant buds and by coating the entire scion as well as cut surfaces of the stock with melted wax, successful grafting can be accomplished even as late as July. In fact, using this improved method of waxing in an experimental way, successful grafts have been made by the writer every month of the year from November to August. Results of this test are shown in Table 2. However, for practical use, just before and as the buds are starting in the spring is the best time to do grafting work.

Whip grafting of seedling root stocks for growing young fruit trees may be done during the dormant season in winter and the grafted stocks stored in moist sawdust or moss in a cool cellar or buried out-of-doors until time for planting in the spring. Topworking of trees by the cleft-graft method is generally done immediately before or just as the growth is starting in the spring. Some other

forms of grafting, such as bark grafting and bridge grafting, that involve the loosening of the bark are most conveniently done a little later in the spring when the bark has begun to slip well.

TABLE 2.—Comparison of Grafting in Different Months of Year*

Month grafts were set.....	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Total
Number of grafts set.....	36	55	42	69	67	61	30	28	32	420
Number of grafts successful.....	3	7	0	20	50	58	30	26	28	222
Percentage of grafts successful....	8.3	12.7	0.0	36.3	74.6	95.0	100.0	92.0	87.0	54.8

*In this experiment all scions were entirely coated with melted paraffin brush wax at time of setting. The paraffin wax used proved too brittle for winter work. Undoubtedly, if a brush wax of more elastic properties were available, a higher percentage of grafts would live when set during the fall and winter.

TOPWORKING

The changing over of the entire top of a tree to an entirely different variety is called topworking (Fig. 1). Mature trees may be topworked, but the older the tree and the larger the branches the more difficult is the task. Topworking of trees takes advantage of the root system already present and brings the trees into production more quickly than can be done by planting young trees. In selecting limbs for topworking, each tree must be studied as an individual problem and limbs selected for grafting with reference to the future framework and form of the tree (Fig. 1). Vigorous limbs, well distributed around the tree and sufficiently wide-spaced on the trunk so that no bad crotches are formed, should be selected. A vigorous, upright branch in the center of the tree which will be the future central leader of the tree should be selected for grafting. A branch slightly leaning toward the prevailing wind is best for this purpose. Trees may be trimmed during the winter season preparatory to grafting and the stubs to be grafted coated with melted brush wax to prevent drying out. The younger the trees the fewer the limbs that need to be grafted and the easier it is to find limbs of desirable size near the trunk. The limbs should be cut off as close to the trunk as necessary to obtain a limb diameter of from 1 to 3 inches on which to graft. Where the main limbs are too large, these may be cut back to vigorous, lateral branches and these smaller laterals cut for grafting. The majority of the limbs remaining, upon which grafts are not to be set, are then removed. Enough of these limbs are allowed to remain, however, to shade partially the limbs upon which the scions are set and thus protect them against sunscald; for this reason, on mature trees it is neces-

sary to extend the time of topworking over two or three seasons. During the growing season after the grafts are set, water sprouts will grow in profusion over the limbs and around the grafts. These, for the most part, should be cut out, but a few should be cut back and allowed to remain as they will furnish sufficient shade after the first season so that the majority of the heavier wood of the tree can be removed. After two or three seasons when the grafts have made sufficient growth to shade themselves and the main trunk parts of the tree, all other growth is removed. The graft growth itself is next thinned out. Where double grafts have grown, one each of these is removed and the tree pruned to correct its form.

Fig. 1.—A. Twelve-year-old apple tree before top grafting. B. Twelve-year-old apple tree pruned and limbs cut for cleft grafting

The four principal methods of grafting used to topwork trees are: cleft grafting, whip grafting, bark grafting, and budding.

CLEFT GRAFTING

Cleft grafting is the most commonly used method of topworking. Limbs from 1 to 3 inches in diameter are grafted in this manner. Larger limbs may be grafted by using two clefts parallel

to each other, one on either side of the center, and inserting four scions. On young trees set from 2 to 4 years the scions may be placed in the trunk; on older trees they are placed in the branches.

Cleft grafting of young trees.—Where young trees set from 2 to 4 years are to be top grafted, the trunk is cut off 18 inches to 2 feet from the ground and scions cleft grafted into it. One method used successfully on young trees is to cut them off with a sloping cut, setting one long scion in the stock at the top of the slope (Fig. 2, A). The stock should be trimmed off at the top of the slope to the width of the scion, and the slope cut on the stock so that the scion will be set on the windward side. This one scion may be from 10 inches to 2 feet long and the terminal bud may be allowed to remain. The long scion may even be debudded, only the buds allowed to remain that are wanted for scaffold branches, as when starting a yearling tree. The entire scion and cut surfaces of the stock are coated with melted brush wax. If the grafting is well done, the scion will grow into a branched top in one season (Fig. 2, B). Several successful plantings have been started in Ohio by the setting of large, vigorous, 3-year-old trees from the nursery and topworking these to desired varieties in this manner. F. H. Ballou

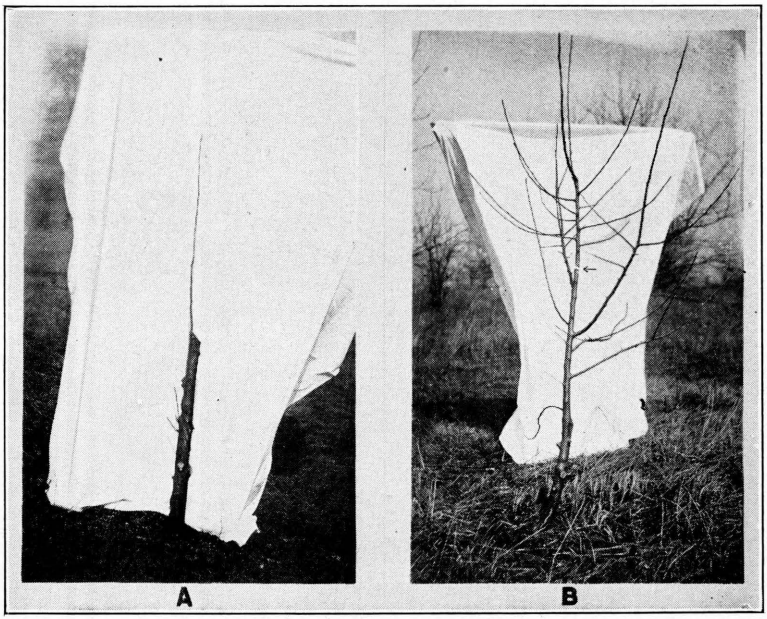

Fig. 2.—A. Young tree cleft grafted in trunk using one long scion. B. Young tree grafted with long scion after two seasons' growth. Small arrow indicates top of scion when set

first used this method in starting trees of the desired varieties in his orchard at Newark, Ohio. This method is especially valuable in top grafting varieties like Grimes on hardy stocks for resistance to collar rot or other weaknesses of stock or root.

In the topworking of young trees too large to set scions in the trunk, small branches about one inch in diameter are often cleft grafted (Fig. 3). These branches are cut off with a beveled cut and one scion inserted. On these small-sized limbs the pressure of the stock many times does not hold the scion securely enough. In this event, the scion should be bound in the cleft tightly by wrapping. Yarn or strips of worn muslin impregnated with grafting wax have been used for this purpose. The use of waxed tape or strings gets the operator's hands covered with sticky wax. It has been found that by the use of paraffin brush wax this difficulty can be overcome. A piece of old muslin can be taken along and narrow strips torn off as needed. The wrapping is done with these strips dry. A touch with melted wax will stick the loose end down. The entire wrapping is then brushed with melted wax, the hot wax soaking into and through the cloth, sealing the graft air tight. This same method may be used wherever binding or wrapping is necessary in any grafting operation.

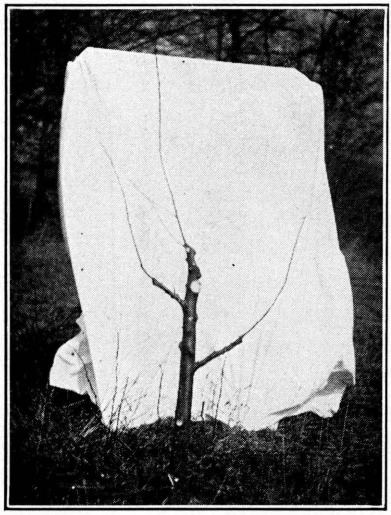

Fig. 3.—Young tree one year after grafting in branches

Cleft grafting of older trees.—In making a cleft graft in older wood the limb to be grafted should be sawed off with a fine-toothed saw. A point should be selected for this cutting where the wood is smooth and straight grained for at least 4 inches below the point where the limb is cut off. A special tool known as a grafting tool may be used to advantage in making the cleft and in holding it open to receive the scion (Fig. 4). This tool is made of good steel and consists of a concave cutting edge with a hook or handle on one end and a turned up wedge on the other. The cutting edge of the tool is concaved in shape so that the limb will be cut clean first at the edge, before the wood splits, thus giving a clean cut surface in which the scion may be set. The grafting tool may be hammered into the

wood with a small wooden or rubber mallet. In splitting the stubs of side branches, the cleft should be made in a horizontal direction; and, on vertical stubs in the top of the tree, the split is made in a direction allowing one scion at least to face the prevailing wind.

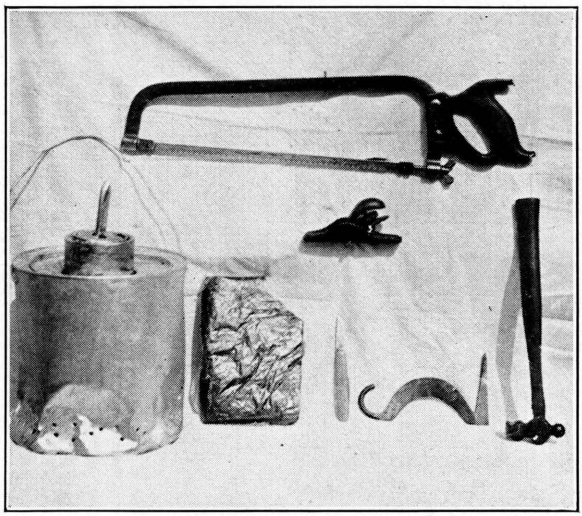

Fig. 4.—Outfit used in grafting, includes wax melter, cake of brush wax, knife, grafting tool, hammer, block plane, and saw

On limbs that are cut to a bevel and only one scion set, the scion should always be placed on the upper or outer edge at the highest point of the bevel. After the cleft is made the grafting tool is removed, turned over, and the wedge on the outer end hammered into the cleft at the center of the stub. This opens up the cleft so that the scion can be easily inserted without tearing the bark (Fig. 5).

Scions are usually cut from three to five buds long for topworking. The scion is cut off directly above the top bud. Beginning at the base of the lowest bud, the lower end of the scion is cut in a wedge shape with uniform, even sides and slightly thicker on the bud side. This wedge should not usually be over 1½ to 2 inches in length and should be blunt on the lower and front end, rather than drawn to a fine, long point. The idea is to cut the scion as nearly to fit the cleft in the stock as possible. A steady continuous stroke with a sharp, thin bladed knife is essential as the cut surface should be smooth and even. A very small block plane may be used for shaping and smoothing up the cut surfaces of the scion.

After the wedge of the grafting tool is driven into the cleft at the center of the stub, the handle is pushed down slightly to spread the cleft farther apart. The prepared scions, one on either side, are then inserted in the cleft with the wide edge of the scion outward, so that the stock will clamp the scion most firmly in the region of the cambium. They are then slipped downward into the

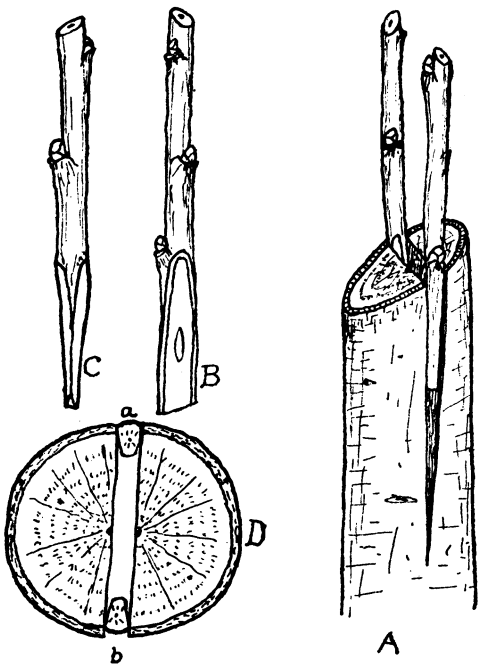

Fig. 5.—The cleft graft.

A. Cleft graft completed ready for waxing.
B. Side view showing bevel of scion.
C. Back view showing wedge shape bevel of scion.
D. Cross section of cleft graft.
   a. Incorrect method of setting scion, no cambium contact.
   b. Scion correctly set to secure cambium contact.

cleft until the lower bud is close to the cut surface of the stock. An effort must be made to make the line of the cambium layer of the scion as nearly continuous as possible with that of the stock. Since the bark of the stock is thicker than that of the scion, the scion will always be a little towards the center rather than flush with the outside bark of the stock (Fig. 5, D). Sometimes the scion is tilted

very slightly to the outside, as this insures a contact of the cambium layers at some point, although this is usually not necessary. After the scions are in place, the wedge of the grafting tool is carefully worked out so as not to disturb the position of the scions until the stock has tightened sufficiently to hold them firmly in place. All cut surfaces of both stock and scion should then be carefully covered with wax to keep the parts from drying out before union has taken place. Care should be taken that the split on the sides and top of the stock is filled and covered, that cut surfaces remaining exposed on the sides of the scion are covered, and that no air

TABLE 3.—Comparison of Coated and Uncoated Scions

Paraffin brush wax used

Scions set		Successful grafts		
Uncoated	Coated	Uncoated	Coated	Difference in favor of coating
Number	*Number*	*Per cent*	*Per cent*	*Per cent*
83	337	19.2	61.1	41.9

holes remain in the wax at the angle where the scions meet the stock. A small bit of wax should be placed on the tip of the scion to seal this cut end. A good brush wax (See Page 20) is to be recommended for waxing the grafts. Scions may be cut and dipped in melted wax before the grafts are set. The scions are then already covered, and, when set, all the waxing that remains to be done is to cover the cut surfaces in the usual manner. In this way the scions receive a thin and more uniform covering than when the wax is brushed on in the orchard.

WHIP GRAFTING

In top grafting trees, one may want to place grafts in limbs less than one inch in diameter. This is especially true when it is desirable to graft small trees without taking the chances of grafting in the trunk. Results from whip grafting are better when the stock and scion are of about equal size. In making a whip graft a sloping cut is made on one side of the upper end of the stock and a like cut just to match made in the lower end of the scion. A tongue is cut in both scion and stock midway of the sloping cut and with the grain of the wood. When the scion and stock are brought together, the tongues each slip into the slits made for them and are thus held together. The cambium layers of stock and scion should be matched so that they make contact with each other at the tongues. When the scion is smaller than the stock it must be placed

to one side in order to do this (Fig. 6). If the work is carefully done, there is a possible contact of cambium on three surfaces. Since the stock is not large enough to exert much pressure towards holding the scion in place, this type of graft is usually wrapped to hold the parts securely together. Waxed yarn or cloth strips may

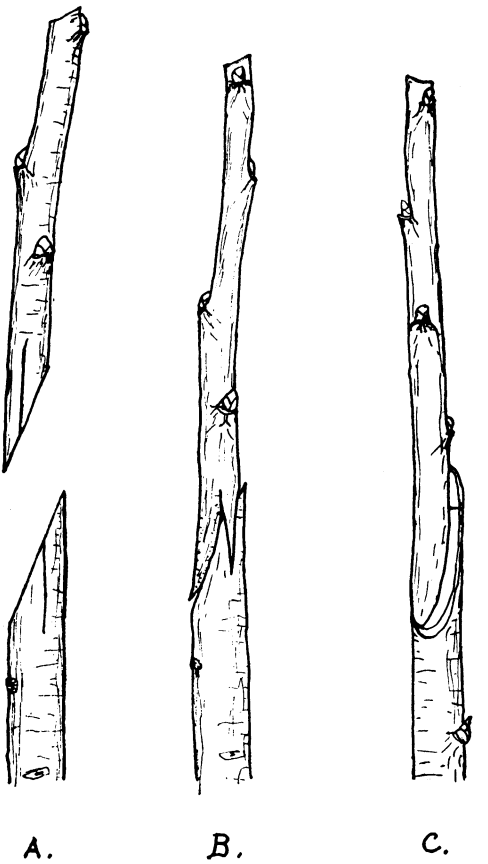

Fig. 6.—The whip graft.

A. Shows scion and stock cut to match.
B. Scion inserted on stock.
C. Stock larger than scion. Shows scion set to one side to match up cambium layers.

be used for this purpose. Small rubber strips, 3/16 inch wide by 5 inches long, have recently been used for wrapping whip grafts and are ideal for this purpose, as they exert the necessary pressure to hold the parts together and expand with the growth. After the graft is wrapped, it is then thoroughly covered with a thin coating of wax.

This method of whip grafting is used to some extent in growing young trees. Small seedling trees of ½ to ⅝ inch in diameter are root grafted in this manner during the winter, stored in a cool, moist condition to callous, and set out in the nursery row in the spring. Better growth is secured if the scion is cut so that the upper bud is directly above the tongue on the side where the cambial contact is made (Fig. 6, B). Since root grafts are buried entirely, except for the upper bud of the scion, in setting in the nursery row, it is not necessary that they be waxed.

BARK GRAFTING

Bark grafting is done in the spring when the bark peels readily. It is preferred by some to cleft grafting because it is done without splitting the wood. It is used also in grafting limbs that are larger than are usually cleft grafted. Its weakness lies in the fact that the grafts are not sufficiently supported and, if vigorous growth ensues, are likely to be blown and whipped out by the wind. Several methods of bark grafting are used, but all consist of placing the scions just under the bark. In one method largely used, the limb is cut off as for cleft grafting. The scion is cut with a long bevel on one side and a very short bevel on the other so as to leave a sharp chisel edge at the lower end. The scion is then held in place on the outside of the bark and the bark slit down with a knife approximately to correspond with the length and width of the bevel surface of the scion. The lower end of the scion with the long bevel towards the stock is then pushed under the bark between the two cuts, the bark peeling as the scion is pushed downward. The lifted bark is then cut away even with the top of the short bevel and the scion tacked tightly to the stock with two small nails or brads (Fig. 7, A, 1). Other scions at intervals of 2 to 4 inches are put in place in the same manner entirely around the stub. The entire scions and cut surfaces of the stock are covered with melted wax. In shaping the scion, some prefer to cut half way through the scion at the top of the long bevel forming a shoulder that is placed against the top of the stock, giving added support to the scion (Fig. 7, A, 2). Another method is to cut the scion to a very long slim bevel from one side, slip it down between the bark, and tack it in place. If the bark is heavy, it is necessary to cut the bark in front of the scion before it will loosen enough to allow the scion to be pushed down into place. The scion is then secured and waxed in the usual way. In placing scions in bark grafting, care must be taken that they are cut with a smooth surface as nearly as possible

to fit the surface of the stock. A small block plane has been found very valuable in smoothing up and cutting the long bevel in this type of grafting. The knife of the plane may even be ground to slightly rounded cutting edge instead of straight. This will enable the beveled surface of the scion to be cut slightly concave to fit the

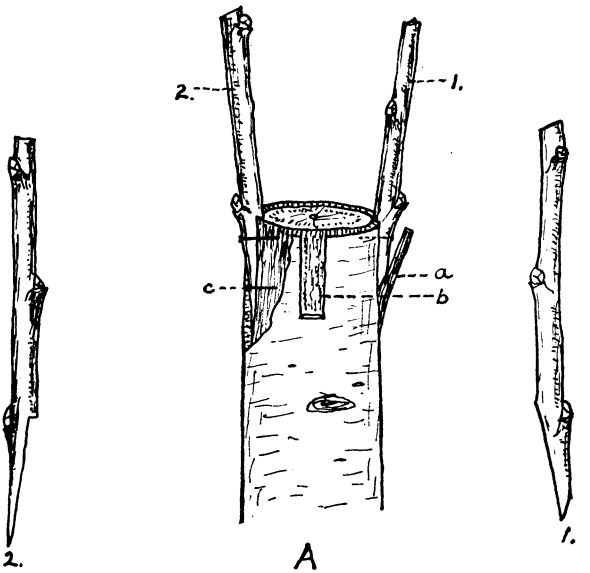

Fig. 7.—A. Showing two methods of shaping scion for bark grafting. Graft ready for waxing.

- **a. Indicates point where strip of bark is cut off. Strip of bark was lifted by scion when it was pushed into place.**
- **b. Strip of bark cut and lifted out ready for scion cut with notched bevel.**
- **c. Small nail or brad used to tack scion to stock.**

1. **Showing scion shaped with long and short bevel.**
2. **Showing scion cut with shoulder or notched bevel.**

surface of the stock more closely. The small nails or brads used in bark grafting should be very slender so as not to split the scion and should have wide heads so as to draw the scion closely to the wood. Those commonly known as cigar box nails or small nails used in making up bee supplies are fine for this purpose.

BRIDGE GRAFTING

Bridge grafting is used to repair damage done to trees by mice, rabbits, or other bark peeling or eating animals. It may be used to advantage in bridging over damaged areas of the trunk caused by blight cankers, winter injury, disease, or serious mechanical injury. Bridge grafting might be called a phase of bark grafting, differing mainly in the fact that both upper and lower ends of the scion are grafted into the stock or tree. In preparing the tree for bridge

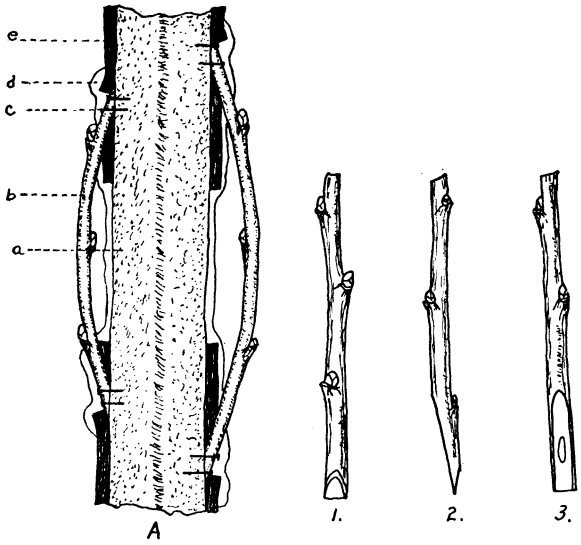

Fig. 8.—A. Longitudinal section showing details of bridge graft.
a. Wound. b. Scion.
c. Small nail or brad. d. Wax. e. Bark.
1. Base of scion showing short bevel.
2. Base of scion showing side view of bevels.
3. Base of scion showing long bevel.

grafting the damaged bark should be cut back to clean, live, healthy bark. Scions of sufficient length should be selected to reach over the injury to healthy bark on either side, and extra length should be allowed for a bow or spring in the scion when finally set. Both upper and lower ends of the scion are beveled and the bark on the stock measured and cut as for bark grafting. Care must be taken that the bevels on the scion are both on the same side. The lower end of the scion is fitted into the slot in the bark cut for it and secured with two small nails. The free end is then sprung down and fitted into the slot prepared for it on the upper side of the

injured area, and this is nailed in place. Enough scions should be set over the injured area so that they will not be over 2 to 4 inches apart. Water sprouts or long one-year terminal growths make good scions for bridge grafting. All cut surfaces should be carefully coated with wax. The upper ends of the scions should have special care as the wax tends to run off and leave uncovered spaces at the angle where the inner side of the scion meets the stock. The edge of the injured area should be covered with wax; sometimes, the whole surface of the injury is painted with melted paraffin or brush wax. Where the injury extends from the base of the tree out into the roots so far that bridging with scions is impossible, one-year-old nursery trees can be planted at intervals around the base of the tree and the tops grafted into the healthy tissue above the injury (Fig. 8).

BUD GRAFTING OR BUDDING

Budding is employed by nurserymen more than any other method in propagating a desired variety on seedling stock. Apples, pears, cherries, quinces, peaches, and plums may all be propagated by budding in Ohio. Orchardists often use budding in topworking small trees on trunk or branches. It may also be used in topworking older trees by budding on water sprouts or vigorous new growths. When grafts set in the spring have failed to grow, vigorous sprouts will usually grow out around the stub. A few of these more vigorous sprouts may be selected and budded in the late summer.

The essential considerations in budding are the same as in grafting, except that a single bud is made to grow upon the stock instead of a scion containing three or more buds. The success of the operation depends upon the uniting and growing together of the cambium of bud and stock. Shield or T budding is most generally used and takes its name from the shape of the small piece of bark cut off with the bud or the cut made in the stock. In Ohio, budding is generally done during the latter part of July or during August. The exact time of budding depends upon the ripeness of the buds on the current season's growth and upon the ease with which the stock peels. Stocks should be in good growing condition and bark slipping easily for success in budding. Buds should be secured from the variety of fruit desired, the buds in the axils of the leaves on current season growth being used. The buds should be well formed. Vigorous shoots having formed their terminal buds generally contain good mature buds. Buds taken from the central

two-thirds of the growth are better than buds taken from the tip or bottom ends of the growth. These growths are cut from the tree and the leaves trimmed off, leaving about half an inch of the petiole of the leaf to act as a handle when inserting the bud. These sticks containing the buds are then wrapped in moist cloth to keep them fresh while budding. In budding seedling trees, the leaves are rubbed off and a smooth place in the bark on the north side of the tree as close to the ground as possible is selected for the place to insert the bud. In budding on the limbs in topworking, buds are placed in an outside position or on top of the limb. Buds are more successful when placed on current season or one-year wood. With proper care buds may be grown on older wood. The thicker the bark the less likely the buds are to succeed.

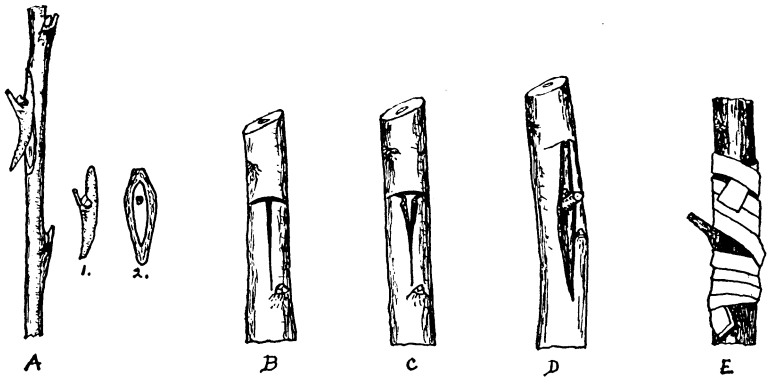

Fig. 9.—A. Showing bud stick with bud partly removed.
1. Bud removed, front view.
2. Bud removed, showing shield-shaped rear view.
B. Showing T-shaped slot cut in stock.
C. T slot ready to receive bud.
D. Bud in place on stock.
E. Bud wrapped with rubber budding strip.

In shield or T budding, the cut in the stock is made in the shape of a T. The bark of the stock is first slit for a little more than an inch lengthwise of the stem. Next, the knife edge is rolled across the stem at the top of the lengthwise slit completing the T-shaped cut. If the crosswise cut is made with a downward slant to the knife the corners where the two cuts cross each other may be raised up slightly when the knife blade is brought out. If the bark does not raise up easily enough to admit the bud without injury by this method, the edges must be loosened and raised with the tip of the knife. The bud is now cut from the twig in the shape of a shield, starting the knife blade about ½ inch below the bud, cutting

deep enough into the twig so as not to injure the bud, and running up under the bud and out again about ½ inch above the bud (Fig. 9, A). The small bit of wood cut out with the bark is sometimes removed, but ordinarily it is disregarded. The bud is now grasped by the projecting petiole, inserted in the T-shaped opening, and pushed downward into place. If the bark at the top of the shield projects above the cross cut, it should be cut off even, so that the under surface of the bud fits closely to the stock. The bud is then wrapped to hold it tightly against the stock until the union takes place. Several wrapping materials have been used, among them narrow strips of cloth and raffia. More recently, specially made rubber budding strips have been made by rubber manufacturers and are ideal for this purpose. The size of these strips varies from 3½ inches long and 3/32 inch wide to 5 inches long and 3/16 inch in width, according to the size of the stock and the length of time the wrapping is to remain. The great advantage of wrapping with rubber strips is that they maintain a constant pressure, expanding with the growth of the stock. These strips also rot off and need not be cut, as is necessary with raffia or other wrapping materials usually used. In wrapping a bud the wrap is started below the bud, crossing the first turn to hold it in place, continuing the wrap up to the bud, then above the bud, and placing the free end back under the last turn which holds the end in place (Fig. 9, E). This method holds the bud tightly in place and makes a smooth wrap without tying any knots. Three or four turns of the wrapping both below and above the bud are sufficient. No waxing of the buds is necessary. If the budding has been successful, the bud will have united with the stock at the end of about 2 weeks, the petiole will have dropped off, and the bud will have a plump, healthy appearance. If the wrapping material has not loosened by this time it should be cut. The bud will remain dormant the remainder of the season but should start growth the next spring. The stock should be cut off just above the bud in the spring and care taken the first few weeks of active growth to remove all sprouts arising from the stock around or directly below the bud. The strength of the tree will go into the growth of the bud in this way; otherwise, the numerous sprouts may smother out the bud or cause it to grow but weakly.

WAXES USED IN GRAFTING

Several kinds of grafting waxes are used in grafting work. Most grafting waxes are combinations in some proportion of rosin, beeswax, paraffin, tallow, and linseed oil. One of the oldest formulas for grafting wax known to horticulture is that for hand

wax, or soft wax. Most grafting wax becomes soft when heated, and this hand wax becomes soft enough to work at the temperature of the hands. It is kept workable in the orchard by holding it in the hands and working it between them.

FORMULA FOR HAND WAX

Rosin	4 parts
Beeswax	2 parts
Tallow	1 part

These materials should be melted together slowly and not allowed to boil. When melted and well mixed, pour into cold water to cool. Grease the hands well with tallow and pull the wax in the same manner as taffy until it is straw colored and uniform in texture. The wax may then be used or stored in rolls in oiled paper. For use in very cold weather, ½ pint of linseed oil may be substituted for the tallow; this makes a softer wax. For a harder wax increase the amount of rosin.

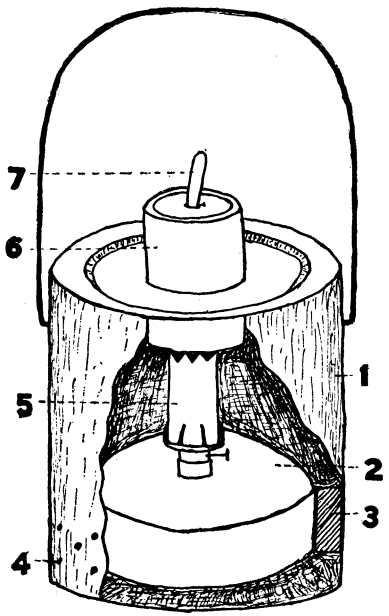

Fig. 10.—Details of home-made wax melter for use in the orchard

1. **Wide topped metal can.**
2. **Metal kerosene lamp.**
3. **Wood block.**
4. **Hole for ventilation.**
5. **Metal chimney, notched.**
6. **Pint paint can.**
7. **Small paint brush one inch wide.**

BRUSH WAX

Because of the inconvenience of working with sticky hands and the ease of applying formulas known as brush waxes, these waxes, applied in melted form, have increased in use tremendously. They are applied with a brush in melted condition and harden on the grafts after being applied. They flow into crevices, cover well, and can be applied in a thin coat compared with hand wax. Brush waxes are kept in melted condition in the orchard by means of small portable heaters of simple construction. Orchard supply companies are now selling small heaters for this purpose, or they may be constructed at home by the orchardist. The one illustrated (Fig. 10) was made at very little expense, using a wide-mouthed metal can, a small metal kerosene

brooder lamp with metal chimney, a pint paint can, and a small brush one inch wide. The handle of the brush should have a small nail driven into it to rest on top of the can lid so that the brush will suspend in the wax and not rest on the bottom where it would burn and cause inconvenience. Such a heater has been used by the writer for 4 years and has given excellent service.

High-melting-point paraffin has been increasingly used as an ingredient of brush waxes in the past few years. Plain paraffin, if applied alone, however, has a tendency to crack in cold weather and flake off. Satisfactory, commercial paraffin brush waxes may be purchased. Parapin wax sold by orchard supply companies is one of the best. These waxes contain other ingredients mixed with paraffin to give it added elasticity and sticking qualities. The success of using paraffin alone as a brush wax after severe weather is past depends largely on applying it while almost smoking hot. It will then go on in a thin, almost transparent coat much like varnish and will stick remarkably well. A high-melting-point paraffin is preferred as it will not be affected by hot weather.

A formula for brush wax recommended by J. A. Neilson of Michigan and successfully used by the writer in Ohio for the past several years both for coating scions and for brush wax in grafting is as follows:

PARAFFIN BRUSH WAX

Rosin	1 pound
Linseed oil	3 fluid ounces
Paraffin	5 pounds

Melt the rosin and linseed oil together and pour into the melted paraffin. Mix well. Pour out into a shallow pan lined with oiled paper to cool in a cake 1 to 2 inches thick. This makes a convenient sized cake which can be broken up and melted in a heater as wanted.

TABLE 4.—Comparison of Different Proportions of Pick-up Gum to Paraffin for Coating Wax

Mixture	Grafts set	Successful grafts	
	Number	*Number*	*Per cent*
Pure Pick-up Gum	22	0	0
Paraffin, 4 parts; Pick-up Gum, 4 parts	45	18	40
Paraffin, 4 parts; Pick-up Gum, 1 part	53	52	98

Another paraffin mixture used especially for coating scions and also suitable for covering grafts is: Paraffin, 4 parts; Pick-up Gum, 1 part. As will be seen by the results in Table 4, it is important that these proportions of paraffin and Pick-up Gum be strictly adhered to.

Experiments show too great a proportion of Pick-up Gum to cause the wax to run off when the sun hits it, leaving the grafts uncovered. Pick-up Gum is a glue-like substance sold by commercial manufacturers largely for glueing packages, labels, etc. This material is primarily to keep the paraffin from flaking and to give it added adhesive qualities.

These almost transparent brush waxes may be used in covering the entire scions, buds and all, as well as the cut surfaces of the stock, in grafting. It may be used for coating young nursery stock before setting out to keep it from drying out or for coating scions or nursery stock for long shipment. By use of this wax on scions having latent buds that have not started growth, grafting may successfully be done even during the growing season. The covering of the entire scion eliminates any possible drying out even under adverse conditions. This method was first used in grafting nut trees where conditions had to be specially favorable. It gave such favorable results that it has since been used quite generally in the grafting of fruit trees.

Another brush wax that was considered standard before the use of paraffin and which is widely used and recommended where a tough lasting wax is wanted is:

STANDARD BRUSH WAX

Rosin	5 parts
Beeswax	1 part
Linseed oil	¼ part
Lamp black or powdered charcoal	½ part

Melt rosin slowly, add beeswax and melt, then add linseed oil. The mixture is then taken from the fire and the powdered charcoal or lamp black slowly stirred in, a little at a time. The charcoal or lamp black gives the wax toughness and pliability.

ALCOHOLIC BRUSH WAX

Pulverized rosin	16 parts
Tallow	1 part
Wood alcohol	8 parts

Melt the tallow. Then add the pulverized rosin and heat until entirely melted. Remove from the fire and stir until partially cool. Then add the alcohol gradually until the cooled mass has the consistency of paint. This wax must be kept in a sealed container, or the alcohol will evaporate and the wax will harden. This wax may be painted on cold with a brush, and the evaporation of the alcohol after it is applied leaves the grafts covered with a coating of wax.

Besides its use in grafting, this alcoholic wax may be used for painting the trunks of young trees for protection against injury from rabbits.